

CLAIMS

What is claimed is:

- 5 1. A method for integrated ophthalmic illumination comprising:
 illuminating a region within the eye with light of a plurality of different colors, one of which is yellow; and
 forming images of the eye region provided by light of
10 each of the different colors.
2. The method of claim 1, wherein the images are formed sequentially, and further comprising:
 combining the sequential images so as to obtain a
15 combined image.
3. The method of claim 2 wherein the different colors further include red and green and said step of forming images includes treating the images provided by red, yellow and green
20 light as the red, green and blue image components, respectively, and the combined image is a high resolution color image.
4. The method of claim 1 wherein said step of illuminating
25 is performed by supplying light from a lamp source composed of a plurality of smaller light sources that each provide light of a respective one of the plurality of different colors.
5. An integrated ophthalmic illumination apparatus
30 comprising:

means for sequentially illuminating a region within the eye with light of a plurality of different colors, one of which is yellow; and

means for forming sequential images of the eye region provided by light of each of the different colors.

6. An integrated ophthalmic illumination apparatus comprising:

a light source for producing light having a plurality of color components;

an optical filter unit disposed in the path of the illumination beam for selecting only light wavelengths that are required for imaging while avoiding unnecessary irradiation of the eye;

a separation unit for sequentially separating light from said optical filter unit into red, yellow, and green color components of said light beam;

an optical system disposed for directing each of the light color components sequentially into a region within the eye, so as to produce sequential color images;

an image capturing device disposed to obtain successive images of the region within the eye provided by each of the color components; and

a computer processor connected to form from the successive images at least one of a high resolution color image and a monochromatic image.

7. The apparatus of claim 6 wherein said light source is one of: an arc lamp; a filament lamp; a gas lamp; a laser; and a plurality of diodes.

8. The apparatus of claim 6 further comprising electronically-controlled means for controlling the intensity of the light color components directed into the region of the eye.

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9. The apparatus of claim 8 wherein said electronically-controlled means comprise a fast liquid crystal shutter.

10. The apparatus of claim 9 wherein said processor controls said shutter for each image obtained by said image capturing device.

11. The apparatus of claim 6 wherein said separation unit is a filter wheel.

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12. The apparatus of claim 11 wherein said imaging means operates at a frame rate and said filter wheel rotates at a speed of one-third of the frame rate of said imaging means.

20 13. The apparatus of claim 6 wherein said separation unit is a filter wheel having three color filters, and further comprising electronically-controlled means for controlling the intensity of the light color components directed into the region of the eye, wherein said electronically-controlled
25 means are operative for allowing light through not more than two of said filters during image alignment and focusing of the imaging optics in order to reduce the amount of light directed onto the eye, while enhancing for focus a chosen retinal layer by choosing an appropriate illumination .

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14. The apparatus of claim 13 wherein images acquired during selected illumination are displayed as grey-level, black and

white, images during alignment and focusing of the imaging optics in order to improve visual contrast.

15. The apparatus of claim 6 further comprising a neutral
5 density filter disposed in the path of light from the source or in the path of the collimated beam.

16. The apparatus of claim 6 further comprising a long-pass
10 optical filter to transmit near-infra-red radiation from the light source.

17. The apparatus of claim 6 wherein said separation unit
comprises a long-pass red filter, and further comprising a
short-pass optical filter that acts together with said red
15 filter to form a band-pass near-infra-red transmitting filter.

18. The apparatus of claim 17, further comprising a mechanism
for effecting fast withdrawal of said short-pass optical
filter for switching from near-infra-red imaging to color
20 imaging.

19. The apparatus of claim 6 further wherein said optical
system comprises a condensing lens for reducing the diameter
of said illuminating light beam.

25 20. The apparatus of claim 6 wherein said image capturing device is a monochrome electronic imaging sensor.

21. The apparatus of claim 6 wherein said image capturing
30 device is a color camera.

22. The apparatus of claim 6 wherein said separation unit comprises: an RYG dichroic X-cube splitter producing two deflected side emerging channel beams; two tilted mirrors that deflect said side emerging channel beams to provide two light beams parallel to said collimated light beam; and an X-cube combiner.

23. The apparatus of claim 6 wherein said separation unit comprises a series of tilted beam splitters.

24. The apparatus of claim 6 wherein said light source comprises a plurality of small light sources.

25. The apparatus of claim 6 wherein said separation unit is a filter wheel having three color filters, and at least two of said filters have respectively different sizes, yielding different exposure and frame times for each color in order to compensate for the selective color transmittance of the sclera.

26. The apparatus of claim 6 wherein said separation unit is a filter wheel having red, yellow, and green color filter sections substantially equal in size and a transparent section smaller than each of said color filter sections.

27. The apparatus of claim 6 wherein said separation unit is a filter wheel having three color filters, and further comprising a second filter wheel for use in at least one of monochromatic illumination and excitation with angiographic agents.

28. The apparatus of claim 27 wherein said second filter wheel further comprises a transparent section to allow the full spectral content of said light beam to pass through said first filter wheel.

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29. The apparatus of claim 6 wherein said separation unit is a filter wheel comprising four filter sections, with sections for red, yellow, and green being substantially equal in size and said red, yellow, and green sections being larger than a section of wavelength range adequate for excitation of angiographic agents.

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30. Claim 29 wherein the section of wavelength range adequate for the excitation of angiographic agents is a blue section that is adequate for fluorescein angiography.

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31. Claim 29 wherein the section of wavelength range adequate for the excitation of angiographic agents is a near-infra-red section that is adequate for indocyanine green angiography.

20 32. The apparatus of claim 6 wherein said separation unit is a filter wheel comprising four filter sections, with sections for red, yellow, and green being substantially equal in size and said red, yellow, and green sections being larger than a near-infra-red section of wavelengths range adequate for
25 imaging the retina during alignment and focusing of the imaging optics without stimulating the sensory retina, improving patient comfort, and avoiding eye pupil contraction before color image acquisition.

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33. A method for integrated ophthalmic illumination comprising:

illuminating a region within the eye with light of a plurality of different colors, at least one of which is

5 different from any one of red, green and blue; and

forming images of the eye region provided by light of each of the different colors, the images being composed of red, green and blue components, each component being derived from illumination of a respective one of the different

10 illuminating colors.